Capture RF Systems

70 MHz RF amplifiers at LBNL

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q What have we got?

70 MHz amplifiers located in old HILAC (Heavy Ion Linear Accelerator), building 71 at LBNL

Eimac 8973 tetrodes

≈ 4 amplifiers available for use off-site

Amplifiers have not operated for ≈ 8 years, subject to cannibalization and neglect of ancillary equipment

Operated at 1 MW peak power, 1.5 ms pulse, 2 Hz

One tube now under vacuum

Expect to obtain approximately

⇒ 1.5 MW peak power, ≈200μs pulse, ≈15 Hz (into dummy load)

⇒ four tubes could deliver 6 MW peak to a cavity

q What will we do?

⇒ **Use as much existing equipment as is reasonable to operate and test several tubes at high power**

⇒ **Select and deliver four (or more) operating tubes, and as much ancillary equipment as possible to BNL**

Propose to test amplifiers singly

Tandem testing would require significant modifications to 270 kW power supply capacitor banks and resistors

Will operate four tubes into a single cavity in experiment at BNL

Portable 3-rack housing for PSUP's, monitoring, and controls

Assemble PSUP's and controls into common, convenient rack

Allows controls to be near amplifiers

Allows flexibility in wall-plug power requirements

Most equipment available in the near future for single-amplifier operation

Need to buy some items, many available on loan from other programs

Use alternate PSUP's / amplifiers where less costly than resurrecting old equipment

New items known to be needed at BNL

Design and build:

Plate power supply capacitor bank

100A plate power supply

Plate capacitor bank crowbar system

Coordinating with SNS program on manpower

Technical staff "available" this summer and autumn

Propose to drive amplifiers into dummy, water-cooled, load

HILAC cavity is a possible load. Drift tube quadrupoles have been checked OK, rough vacuum is good so far.

A dummy load would eliminate potential problems with using HILAC cavity as load:

- No vacuum leaks
- No multipacting
- No frequency stability requirements
- No magnets and PSUP's
- No radiation safety issues!

Need:

- Matching section (stub tuner)
- Oversized coaxial lines ?
- Supports
- Water system (could be mains water)
- Directional coupler

Dummy load options

Water load ⇔ Long (length reduced with glycol added)
Narrow band
Need heat exchanger with glycol circuit

Deposited film resistors ⇔ Broadband
Shorter
No heat exchanger necessary

Specifications for cost estimates:

RF Frequency 70 MHz
Peak RF power 6 MW (option of testing single input to cavity)
(also explore possibility of 60 MW to use with future high-power amplifiers)
Pulse length up to 200 μs
Repetition rate 15 Hz

Suppliers:

<u>Altronics</u>

⇒ resistive film load will dissipate 500 kW average, **1.5 MW peak**
⇒ marginal even for single-tube testing
⇒ could use four loads in parallel to reach 6 MW
⇒ also need 4-way combiner
⇒ water cooled
⇒ **$20,000 per load** budgetary estimate

<u>CML Engineering Sales</u>

⇒ resistive film load could dissipate up to 50 kW average, **6 MW peak**
⇒ different resistive components and arrangement
⇒ approximately 6' long
⇒ **$25,000** budgetary estimate
⇒ would mate to MYAT transmission line of appropriate size

60 MW load unreasonable using Altronics approach. CML have expressed an interest in developing loads at this higher power.
VSWR < 1.15:1 is easily achieved.

Need to decide on power and line size requirement.

Coaxial line considerations for future high-power cavity drives

Test cavity has modest average power (18 kW), high peak power (6 MW). Propose to feed cavity with four independent feeds from four tubes, using standard coaxial lines

MYAT Inc. manufacture lines up to 9 3/16” O.D. 50 Ω line for peak power rating 3 MW

Using nominal rating 10 kV/inch, 50 Ω line for 6 MW peak power is 13.55” O.D.

For future operation with 60 MW peak power, need 42.84” O.D. for single 50 Ω line

OK for operation into load (VSWR <≈ 1.15:1 say), but need to consider operation into cavity during filling (VSWR 2:1 doubles voltage on line)

q Draft schedule

August / September	Financial Plan Transfer $50k to LBNL
	Place order for coaxial load and tuner (if not now available)
	Finalize MOU between LBNL and BNL
October	Financial Plan Transfer $$ to LBNL
	Hire Don Howard to oversee technical work on project
	Begin assembly of PSUP's, monitoring, and controls into rack
	Pull cables to capacitor bank
November	Complete rack assembly, including crowbar systems
	Modify capacitor bank
December	Assemble coaxial lines
	Install coaxial load
	Begin testing tubes
January	Complete tube testing
	Ship tubes to BNL
	Ship ancillary equipment to BNL